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(54) Exhaust gas catalyst

An exhaust gas catalyst with a support for catalysis material is described, which consists of randomly oriented ceramic fibers that together provide the flow path for the exhaust gas to be purified. The exhaust gas catalyst is especially characterized by its low weight, small size and low heat content.

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Claims

1. Exhaust gas catalyst with a temperature-resistant support of ceramic material, which has openings for the exhaust gas to be purified, from an inlet to the catalyst to an outlet, and which is coated with the catalyst material, **characterized by** the carrier consisting of randomly oriented ceramic fibers (1) that together form the flow path for the exhaust gas to be purified, from the inlet to the outlet of the catalyst.

2. Exhaust gas catalyst according to claim 1, **characterized by** the ceramic fibers (1) being formed under a vacuum into a support body (4).

3. Exhaust gas catalyst according to claim 1, **characterized by** the ceramic fibers (1) being combined into a mat (13) by means of needles.

4. Exhaust gas catalyst according to claim 3, **characterized by** the mat (13) being wound spirally to a body (4).

5. Exhaust gas catalyst according to claim 1, **characterized by** the ceramic fibers (1) being loosely pressed into a container (12).

6. Exhaust gas catalyst according to claim 2, **characterized by** the ceramic fibers (1) being bonded to each other by means of a bonding agent (2).

7. Exhaust gas catalyst according to one of the claims 1 through 6, **characterized by** the ceramic fibers (1) being bonded to each other by presintering.

8. Exhaust gas catalyst according to one of the claims 1 through 7, **characterized by** the ceramic fibers (1) consisting of an alloy of SiO_2 and Al_2O_3.

9. Exhaust gas catalyst according to one of the claims 1 through 8, **characterized by** the ceramic fibers (1) having a diameter of approximately 1 to 10 µm.

10. Exhaust gas catalyst according to one of the claims 1 through 9, **characterized by** the support (4) being arranged in a cylindrical enclosure (5, 6, 7), with a screen (6) on the inlet side and a screen (7) on the outlet side, where one of the screens (6, 7) is equipped with an attaching flange (8).

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Exhaust gas catalyst

Description

The invention concerns an exhaust gas catalyst with a temperature-resistant support of ceramic material, which has openings for the exhaust gas to be purified, from an inlet for the catalyst to an outlet, which is coated with a catalyst material.

Such exhaust gas catalysts purify exhaust gases coming from internal combustion engines, which in particular contain CO, CH and NO_x as poisonous constituents. The catalyst converts these noxious constituents into CO_2, H_2O or N_2. Catalyst materials to consider are in particular platinum, palladium and/or rhodium.

The supports of traditional exhaust gas catalysts are either ceramic, or made of an appropriately profiled, suitably alloyed steel band. Both known types of exhaust gas catalysts have the disadvantage in common of being relatively voluminous and heavy. They also have a relatively high heat content, so that the exhaust gas catalyst becomes effective in poison removal only after a certain time of vehicle operation, i.e. when it has attained its operating temperature.

For exhaust gas catalysts with ceramic supports, the starting point is usually an appropriately shaped ceramic block in which flow paths are practiced which are subsequently coated with catalyst material. Commonly flow passages are in the form of more or less straightly traversing longitudinal cavities. As already mentioned, such an exhaust gas catalyst must be relatively large, in order to offer the surface area necessary to the catalyst for purification. Hence its installation dimensions include a length of approximately 150 mm and a diameter of 100 mm. Its weight is of approximately 5 kg. Thus, the disadvantage is not only the relatively large heat content, but the fact that because of its low mechanical strength, prior to installation the ceramic support has to be surrounded by a woven metal protection jacket. In addition, other components are necessary, so that its installation becomes more expensive. Finally, this known support can be mechanically stressed only to a limited extent and it is not very temperature-shock-resistant.

While the exhaust gas catalyst with a metal support already mentioned can be more highly stressed mechanically and has a lower heat content, its installation size is still of approximately two thirds of the installation size of the exhaust gas catalyst with a ceramic support discussed previously. Its weight is near 1 kg, so that its heat content is correspondingly reduced. The surface to volume ratio has also been improved. It is now at approximately 4,000 m^2/m^3. Finally, it has a smaller back-draft than the previously discussed known exhaust gas catalyst with the ceramic support. In spite of these basic advantages, this known exhaust gas catalyst is still rather voluminous and its heat content is so high that a lengthy time passes before it attains its operating temperature.

Finally, a sponge-like support for catalyst material is also known, which consists of a nickel-chromium alloy. However, this support is not used to remove exhaust gas poisons, but in particular for deodorization. Apparently this material is not sufficiently temperature-resistant for the purification of exhaust gases from internal combustion engines.

The invention avoids these disadvantages. It is based on the task of proposing an exhaust gas catalyst of the type mentioned initially, characterized in particular by a low heat content and small size.

To accomplish this task, the invention is characterized by the support consisting of randomly arranged ceramic fibers which together form the flow path for the exhaust gas to be purified between the catalyst inlet and outlet.

Thus, according to the invention the very thin ceramic fibers used as support are of the order of preferably a few micrometers; arranged randomly, together they to a certain extent naturally provide the flow paths for the exhaust gas to be purified, without being forced to design such flow paths, as in the initially described exhaust gas catalyst, which also operates with a ceramic support material. Due to the three-dimensional random position and arrangement of the ceramic fibers that constitute the support, the flow paths are not linear as in the state of the art, but are deflected in the shortest distances and many times winding. This perceptibly improves the chance of the molecules to impinge on the support's coating of catalyst material, thus perceptibly also improving its effectiveness. Tests have shown that even so the flow is only minimally throttled.

The material used as support according to the invention is temperature-resistant to well above 1000 °C. An exhaust gas catalyst for conventional personal motor vehicles weighs only approximately 10 g and has a correspondingly drastically reduced heat content. The exhaust gas catalyst according to the invention thus achieves its operating temperature immediately after starting the associated internal combustion engine. Its specific surface to volume ratio lies near approximately 80,000 m^2/m^3 and is hence some 20 times larger than this ratio is for an exhaust gas catalyst with a metallic support, at present already considered good. Its size is correspondingly small. The dimensions are, for instance, a length of 30 mm and a diameter of 50 mm.

The exhaust gas catalyst according to the invention can thus be placed as a kind of pill directly into the tail pipe of motor vehicles, or also of stationary internal combustion engines. The installation costs are very low, in particular because there are practically no accessories that have to be assembled. Not only the installation costs of the catalyst are drastically reduced, but also its manufacturing price, in particular due to the drastically reduced weight of the support. If necessary, the exhaust gas catalyst according to the invention can even be installed in existing motor vehicles or plants, in particular because like a pill, it need only be suitably placed and attached in the tail pipe. This can be done sufficiently close to the outlet of the internal combustion engine, because the material used is highly temperature-resistant.

This material preferably uses an alloy of SiO_2 and Al_2O_3, where the fraction of Al_2O_3 used is higher, the higher the corresponding maximum operating temperature is.

There are several possibilities for the practical realization of the exhaust gas catalyst according to the invention, or of its support. In a particularly preferred form of realization, the ceramic fibers are formed into a support body under a vacuum. Depending on how the procedural parameters are chosen during forming, the support body has a defined specific weight within a rather wide range and hence, also a defined surface to volume ratio. This form of realization offers the advantage that the body can be directly formed to the desired shape, generally a cylindrical form. The fibers are firmly bonded in this

body, so that there is practically no dusting. Its density can be adjusted over a wide range and the surface of ceramic fibers forming the body can be simply provided with the catalyst material.

Another realization form is characterized by the ceramic fibers being connected to form a mat, using needles. This is a very cost-effective manufacture of such a body, which must then however be placed in a suitable enclosure. The density of the body can be easily adjusted over a wide range also in this implementation, and the body can also here be easily provided with the catalyst material.

To manufacture a suitable cylindrical body, the mat can be spirally wound into a body.

Another particularly cost-effective form of realization is characterized by the ceramic fibers being loosely placed in a container. The density can be easily adjusted also here. However, this body is more difficult to coat and there is a danger of the fibers dusting out of container's openings.

In all these realization forms the fibers can be bonded to each other by presintering, which endows the body with added rigidity.

Usually no bonding agent is used during the manufacture of the body by needling, or when the fibers are just placed in a container. However, such a bonding agent can be used to advantage in the first of the implementation forms mentioned, where the ceramic fibers can be formed into a support body under a vacuum. The bonding agent is naturally also subsequently coated with the catalyst material. For cost reasons, this coating will be chosen as thin as possible, usually in the order of magnitude of one to a few micrometers.

Since the support according to the invention is characterized by its very small size, it is preferred to arrange the support in a cylindrical housing with a screen on the inlet side and a screen on the outlet side, such that one of the screens is equipped with an attaching flange. The dimensions of the cylindrical body will be so chosen that it will fir into a tail pipe. The exhaust gas catalyst is attached to the pipe by means of the attaching flange.

This will be further elucidated below.

The invention will be further elucidated below by means of implementation examples, from which other important characteristics will be derived. The figures show:

Fig. 1 - a cross-section through the tail pipe of a motor vehicle into which the exhaust gas catalyst according to the invention has been inserted;

Fig. 2 - view of the exhaust gas catalyst according to Fig. 3 seen from the left;

Fig. 3 - view of the exhaust gas catalyst seen from the right;

Fig. 4 - view in perspective of the actual, catalyst material-coated support of this exhaust gas catalyst;

Fig. 5 - a derived realization form in which the fibers are pressed loosely into a container;

Fig. 6 - schematic of the side view of a needled mat, manufactured from the ceramic fibers mentioned;

Fig. 7 - also shown schematically, a spirally wound cylindrical body made from the mat of Fig. 6;

Fig. 8 - greatly enlarged and also schematic illustration of the randomly arranged ceramic fibers, without bonding agent;

Fig. 9 - schematic view corresponding to Fig. 8, with additionally shown bonding agent

Fig. 10 - view corresponding to Figs. 8 or 9, where the randomly arranged ceramic fibers have been bonded to each other by presintering at their contact points.

Fig. 8 shows randomly arranged ceramic fibers 1. Their length is arbitrary, within wide limits. Their thickness lies near 3 micrometers.

According to Fig. 9, the fibers 1 are bonded to each other with a bonding agent indicated by 2.

Fig. 10 clarifies the bonding of the fibers 1 at their contact points 3, where they are bonded to each other by presintering.

After this basic elucidation of the construction of the support according to the invention, the construction of the exhaust gas catalyst according to the invention will now be further elucidated by means of Figs. 1 through 4.

These figures show a support 4, consisting of the coated ceramic fibers, for instance according to Figs. 8 through 10, coated with the appropriate catalyst material. The support is of cylindrical shape and is inserted into the correspondingly shaped housing, with a jacket 5, an inlet 6 and an outlet 7. Figures 1 and 3 show that the outlet screen 7 was widened to a ring flange 8 with attaching holes 9. In this manner the exhaust gas catalyst can be inserted in a traditional tail pipe 10, through which the exhaust gases of an internal combustion engine - preferably an Otto motor - flow in the direction of the arrows 11.

According to Fig. 5, the fibers 1 can also be loosely pressed into a cylindrical container 12, with inlet and outlet screens as well as attaching flange 8.

According to Fig. 6, the body 4 can also be manufactured by needling the fibers into a mat 13, without using a bonding agent. Fig. 7 shows that the mat 13 can then be spirally wound into a cylindrical body 4, which is then also inserted into a suitable container 12.

Calculations have shown that if fibers with a diameter of three micrometers are used, a body with a volume of 0.0588 dm^3, corresponding to a weight of 0.01176 kg, has sufficient internal surface to purify the exhaust gases of a conventional personal motor

vehicle. In this example the cylindrical body 4 then has a diameter of approximately 50 mm and a length of approximately 30 mm.

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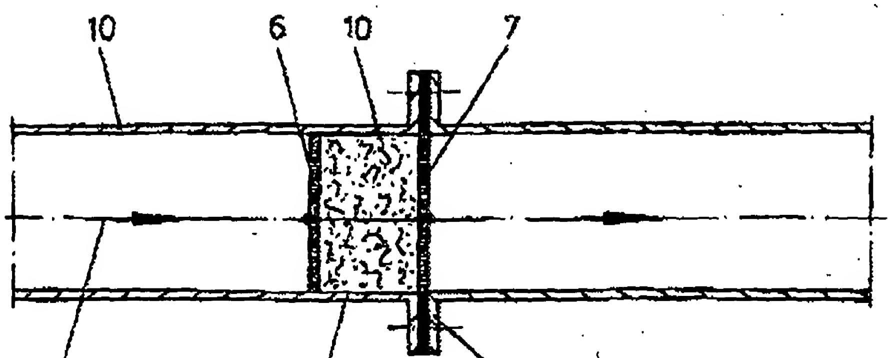

Fig. 1

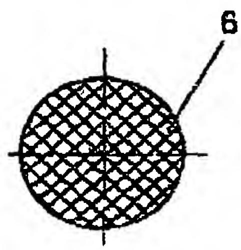

Fig. 2

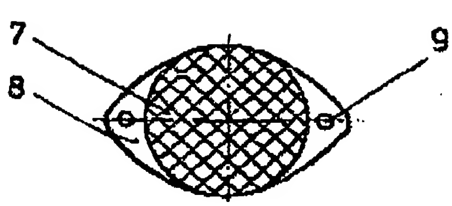

Fig. 3

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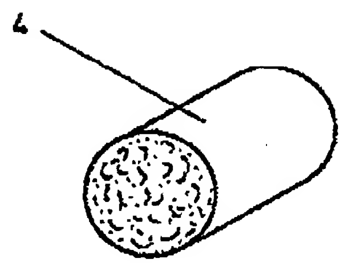

Fig. 4

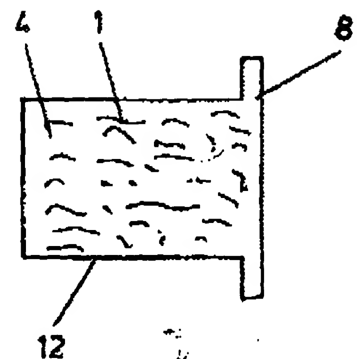

Fig. 5

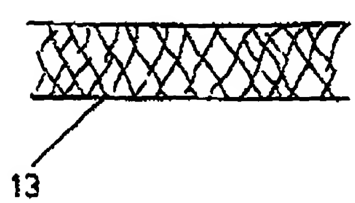

Fig. 6

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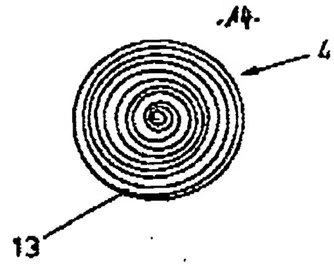

Fig. 7

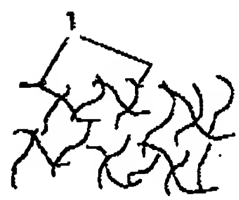

Fig. 8

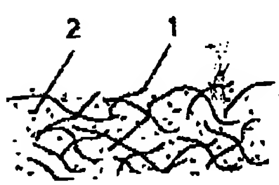

Fig. 9

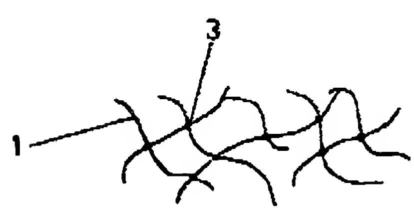

Fig. 10